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(54) Title of the Invention: METHOD FOR ANAEROBIC DIGESTION OF SLUDGE

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Specification

1. Title of the Invention

METHOD FOR ANAEROBIC DIGESTION OF SLUDGE

2. Patent Claims

A method for anaerobic digestion of sludge characterized in that when excess sludge generated in sewage treatment by an active sludge process, mainly sludge composed of microorganisms, is subjected to an anaerobic digestion treatment, a high-voltage pulse is applied to the sludge prior to the anaerobic digestion treatment.

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3. Detailed Description of the Invention

(Field of Industrial Utilization)

The present invention relates to a method for effectively conducting anaerobic digestion of excess sludge generated in sewage treatment by an active sludge process, mainly sludge composed of microorganisms.

(Prior Art Technology)

A large amount of initially precipitated sludge and excess sludge is generated in sewage treatment conducted by a typical active sludge process. Those sludge types have a very high content of water, and dewatering thereof with filters is difficult. For this reason, they were both difficult to discard and to use. Accordingly, the so-called anaerobic digestion treatment is often used, this treatment being conducted to decompose the sludge biochemically by using microorganisms, thereby reducing the amount of solids, and to use effectively the methane gas produced in the process. However, with the conventional anaerobic digestion treatment, the efficiency is very poor. Thus, the VS (organic substances) decomposition ratio is about 50-55% even after about 30 days of retention in standard normal-temperature digestion, that is, at a digestion temperature of about 37°C. The excess sludge composed mainly of microorganisms is especially difficult to decompose by anaerobic digestion.

Various attempts have been made to improve the method for anaerobic digestion of sludge that has poor efficiency. In the representative improved method, the sludge is subjected to a certain pretreatment prior to anaerobic digestion in order to destroy the cell walls of the microorganisms present in the sludge, this pretreatment being conducted by ultrasound treatment (Japanese Patent Application Laid-open No. S58-76200) or by applying pressure with methane and then reducing pressure (Japanese Patent Application Laid-open No. S56-40497).

(Problems Addressed by the Present Invention)

It is an object of the present invention to provide a highly efficient method of anaerobic digestion of sludge which is improved by employing a novel means completely different from the aforementioned conventional pretreatment methods.

(Means to Solve the Problems)

The method of anaerobic digestion of sludge provided by the present invention is characterized by a high-voltage pulse applied to the sludge prior to the anaerobic digestion treatment.

If a high-voltage pulse is applied to the sludge, a major portion of the electric energy is applied to the cell walls of microorganisms present in the sludge; this energy is converted into a membrane compression energy, and the cell walls are destructed. As a result, soluble proteins, sugars, and nucleic acids, and the like, mainly composed of cytoplasm are eluted to the outside of the cells and are rapidly subjected to anaerobic digestion.

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Specific characteristics of high-voltage pulses necessary (or advantageous) for causing the aforementioned destruction of microorganism cell walls differ, depending on the concentration of microorganisms in the sludge which is to be treated and the concentration of co-present inorganic electrolytes, but are generally within the following ranges:

Electric field intensity in the treated sludge: 5 to 50- kV/cm.

Pulse width: not less than 100 μ sec (preferably 200-1000 μ sec or more).

The pulse shape is preferably a square shape, but this shape is not limiting. Further, electrolysis of the sludge can occur under certain application conditions of high-voltage pulses, but this only increases the power consumption and is meaningless from the standpoint of destructing the cell walls. Therefore, it is desirable that the application of pulses equivalent to a continuous current mode which causes electrolyses be avoided.

The following methods can be used for applying high-voltage pulses to the sludge: a method according to which microorganism cells are subjected to high-voltage pulses when they are introduced between the electrode plates and a method by which high-voltage pulses are applied between the electrode plates when the sludge is passed through in a continuous or intermittent mode. The pulse application time is set according to the pulse application method and conditions, so that substantially all the microorganism cells present in the sludge are subjected to at least one pulse (preferably, to several pulses).

The sludge subjected to the high-voltage pulse treatment is mixed with the appropriate amount of nucleus sludge and subjected to anaerobic treatment by the usual method.

(Working Example)

Excess sludge of standard active sludge sampled from a municipal sewage water treatment plant was concentration adjusted so that the organic substance (VC) concentration became 1.0%, placed into a vessel with a capacity of 2000 cc, and then subjected to 20-min. treatment with high-voltage pulses under the following conditions under stirring.

Amount of treated liquid: 1500 cc.

Electrodes: double-wall cylindrical electrodes (electrode spacing 4 mm).

Applied voltage: 10,000 V.

Electric field intensity: 25 kV/cm.

Pulse width: 500 μ sec.

Pulse spacing: 0.1 sec.

After completion of the treatment, a twofold amount of sludge subjected to anaerobic digestion treatment was added as a nucleus sludge to the sludge obtained, followed by intermediate-temperature anaerobic digestion for 20 days.

For comparison, a similar anaerobic digestion treatment was also conducted on the excess sludge that was not subjected to the aforementioned treatment.

The results are shown in Table 1. Conducting high-voltage pulse treatment made it possible to increase significantly the digestion efficiency.

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Table 1

Measurement item	Working Example	Comparative Example
Organic substance (VS) decomposition ratio (%)	55	41
Amount of generated gas (mL/VS-g)		
5 th day	225	130
10 th day	330	200
15 th day	375	245
20 th day	420	290
Gas composition (%)		
Methane	61	57
CO ₂	33	36

(Effect of the Invention)

The results of the working examples demonstrate that the present invention makes it possible to conduct anaerobic digestion of excess sludge at a very high rate and good efficiency. Furthermore, the high-voltage pulse treatment employed as a means for sludge pretreatment in the method in accordance with the present invention is a simple electric treatment. Therefore, if power source equipment is prepared, the optimum treatment conditions can be easily selected according to sludge composition changes. Another advantage is that the treatment apparatus of simple structure and small size can be used.

Representative: I. Sakai, Patent Attorney.

Chauhan Declaration - Exhibit C

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⑭ 発明の名称 汚泥の嫌気性消化法

⑮ 特 願 昭63-25667

⑯ 出 願 昭63(1988)2月8日

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明 細 書

1. 発明の名称

汚泥の嫌気性消化法

2. 特許請求の範囲

活性汚泥法による下水処理において発生する余剰汚泥等主として微生物からなる汚泥を嫌気性消化処理するに当たり、嫌気性消化処理に先立って汚泥に高電圧パルスを加加する処理を加することを特徴とする汚泥の嫌気性消化法。

3. 発明の詳細な説明

(産業上の利用分野)

本発明は、活性汚泥法による下水処理場において発生する余剰汚泥のように、主として微生物からなる汚泥の嫌気性消化を、効率よく行う方法に関するものである。

(従来の技術)

一般的な活性汚泥法による下水処理においては、多量の初沈汚泥および余剰汚泥が発生する。これらの汚泥は非常に含水率が高く、濾過による脱水も困難であるから、そのままでは廃棄も利用も困難である。そこ

で、微生物を利用して生化学的に汚泥を分解することにより固形物となるべく少なくするとともに発生するメタンガスを有効に利用するいわゆる嫌気性消化処理を行うことが多い。しかしながら、従来の嫌気性消化は、標準的な中温消化すなわち消化温度37℃程度、滞留日数約30日でも、VS(有機物)分解率は50-55%程度であり、非常に効率が悪い。嫌気性消化で特に分解しにくいのは、主として微生物からなる余剰汚泥である。

効率の悪い汚泥の嫌気性消化法の改良は種々試みられている。その代表的なものは、嫌気性消化に先立ち汚泥に何らかの前処理を施して汚泥中微生物の細胞壁を破壊するものであって、たとえば超音波処理を施す方法(特開昭58-76200号)、メタンガスによる加圧に続く減圧処理を施す方法(特開昭56-40497号)などがある。

(発明が解決しようとする課題)

本発明の目的は、上記従来の前処理法のいずれとも異なる新規な手段により改良された、効率のよい汚泥嫌気性消化法を提供することにある。

特開平1-210100 (2)

(課題を解決するための手段)

本発明が提供する嫌気性消化法は、嫌気性消化処理に先立って汚泥に高電圧パルスを加える処理を施すことを特徴とするものである。

汚泥に高電圧パルスを加えると、電気エネルギーの大半が汚泥中の微生物の細胞膜に印加され、機械的な膜圧縮エネルギーに変換されて細胞膜を破壊する。それにより、主として細胞質からなる可溶性タンパク質、糖、核酸などが細胞外に溶出し、速やかに嫌気性消化を受けるようになる。

上述のような微生物細胞膜の破壊を生じさせるのに必要な(あるいは好適な)高電圧パルスの特性は、処理する汚泥の微生物濃度、共存する無機電解質の濃度等によって異なるが、おおむね次の範囲にある。

被処理汚泥中における電界強度: 5 ~ 50 kV/cm

パルス幅: 100 μsec以上

(好ましくは200 ~ 1000 μsecまたはそれ以上)

パルス波形は方形であることが望ましいが、これに限定されるわけではない。なお、高電圧パルスの印加条件によっては汚泥の電気分解を生じる得るが、それ

は消費電力を大きくするだけであって、細胞膜破壊のためには無意味であるから、電気分解を招く連続通電に等しいようなパルスの印加は避けることが望ましい。

汚泥に高電圧パルスを加える方法としては、攪拌装置を付属させた汚泥容器中に電極板を挿入し、微生物細胞が電極板間に入り込んだとき高電圧パルスを受けけるようにする方法、電極板間に汚泥を連続的にまたは間欠的に流して高電圧パルスを受けさせる方法、などがある。パルス印加時間は、パルス印加の方法および条件に応じて、汚泥中の実質的にすべての微生物細胞が少なくとも1回(好ましくは数回)のパルスを受けけるように設定する。

高電圧パルス処理を終わった汚泥は、適量の粗粒汚泥と混合して、常法により嫌気性消化処理する。

(実施例)

都市下水処理場から採取した標準活性汚泥の余剰汚泥を、その有機物(VS)濃度が1.0%になるように濃度調整した後、2,000 ccの容器にとり、攪拌しながら、下記の条件で20分間高電圧パルス処理した。処理液量: 1,500 cc

(発明の効果)

実施例の結果から明らかなように、本発明によれば余剰汚泥の嫌気性消化をきわめて高効率かつ効率よく行うことができる。また、本発明の方法において汚泥の前処理手段として採用した高電圧パルス処理は、純電氣的な処理であるから、電源装置さえ用意すれば汚泥の組成変動に応じて容易に最適な処理条件を選択することができ、処理装置も小型かつ簡単なもので済むという利点がある。

電極: 二重円形電極(電極間隔4 mm)

印加電圧: 10,000 V 電界強度: 25 kV/cm

パルス幅: 500 μsec パルス間隔: 0.1 sec

処理後、汚泥に2倍量の嫌気性消化済み汚泥を粗粒汚泥として加え、20日間、中温嫌気性消化させた。

比較のため、無処理の上記余剰汚泥についても、同様の嫌気性消化処理を行なった。

その結果は表1に示したとおりで、高電圧パルス処理を施すことにより消化効率が顕著に向上した。

表 1

測定項目	実施例	比較例
有機物(VS)分解率(%)	55	41
ガス発生量(ml/V5・g)		
5日目	225	130
10日目	330	200
15日目	375	245
20日目	420	290
ガス組成(%)		
メタン	61	57
CO ₂	33	36

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